DOPPLER ULTRASOUND CEREBROPLACENTAL RATIO (CPR) - A BETTER PREDICTOR OF FOETAL OUTCOME IN CLINICALLY SUSPECTED IUGR PREGNANCIES

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ABSTRACT

BACKGROUND

The aim of our study was to evaluate the usefulness of pulsatility index of the UA and MCA as well as ratio of MCA PI to UA PI in the diagnosis of IUGR foetuses. Thus, this study was conducted with an aim to evaluate the use of Doppler ultrasound in the management of IUGR pregnancy as a predictor of adverse perinatal outcome.

MATERIALS AND METHODS

This study included 100 cases with singleton pregnancies of gestational age between 30 to 40 weeks with clinically suspected IUGR and were followed periodically with colour Doppler examination. Doppler assessment i.e. Umbilical Artery (UA) Pulsatility index, Middle Cerebral artery (MCA) pulsatility index, MCA/UA Pulsatility Index ratio (cerebroplacental ratio) was done by experts. The sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were determined for all Doppler measurements. Doppler results were analysed for prediction of perinatal outcome for emergency CS for foetal distress, birth weight, Apgar score, need for NICU admission and perinatal death.

RESULTS

Cerebroplacental ratio (MCA/UA PI Ratio) was most sensitive (Sensitivity 95.6%). It was more sensitive than either UA PI (Sensitivity 91%) or MCA PI (Sensitivity 87.5%) alone in predicting any adverse outcome. Cerebroplacental Ratio and UA PI were equally specific (Specificity=84.6%) and MCA PI alone had comparably low specificity (Specificity=46%).

CONCLUSION

Doppler ultrasound is a valuable modality for the evaluation of patients with clinically suspected intrauterine growth restriction. Abnormal cerebroplacental ratio <1 in particular, is a strong predictor of adverse perinatal outcome in IUGR. Absent and reversed diastolic flow in umbilical artery in IUGR is an ominous finding associated with increased risk of mortality. Foetal Doppler study plays an important role in the management of IUGR pregnancies by early detection of compromised foetuses and timing delivery.

KEYWORDS

Intrauterine Growth Restriction (IUGR), Pulsatility Index (PI), Umbilical Artery (UA), Middle Cerebral Artery (MCA), Cerebroplacental Ratio (CPR).

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BACKGROUND

The definition of small-for-gestational age for a foetus in utero is an estimated foetal weight that measures <10th percentile on ultrasound. This diagnosis does not necessarily imply pathologic growth abnormalities, and may simply describe a foetus at the lower end of the normal range.

Intrauterine growth restriction (IUGR) refers to a foetus with an estimated foetal weight <10th percentile on ultrasound that is because of a pathologic process, has not attained its biologically determined growth potential. It may result in significant foetal morbidity and mortality if not timely diagnosed. The condition is most commonly caused by inadequate maternal-foetal circulation resulting in chronic foetal hypoxia and finally suboptimal growth in utero. IUGR foetus does not reach its growth potential in utero and are affected by some pathological condition, thus should be differentiated from the normal healthy but constitutionally small foetus. The challenge is to identify these pregnancies affected by pathological growth restriction in order to allow timely intervention and reduce perinatal morbidity and mortality. Foetal developmental restriction can occur due to the maternal cause, foetal cause or both.[1] The development of a good uteroplacental circulation is essential for the achievement of a normal pregnancy, when this mechanism fails abnormal vascular resistance pattern develops leading to a compromised foetus.[2]

Maternal causes of IUGR (Adapted from Severi et al 2000)[3] include chronic hypertension, pregnancy-associated hypertension, cyanotic heart disease, diabetes, haemo-globinopathies and anaemia, protein-calorie mal-nutrition, smoking, substance abuse, uterine malformations, thrombophilia, prolonged high-altitude exposure. Placental or umbilical cord causes of IUGR include twin-to-twin transfusion syndrome, placental abnormalities, chronic abruption,

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abnormal cord insertion, cord anomalies, and multiple gestations. Foetuses with chromosomal disorders and congenital malformations are also affected with growth restriction.

IUGR foetuses are at risk of severe morbidity represented by intraventricular haemorrhage, bronchopulmonary dysplasia, necrotising enterocolitis, infections, pulmonary haemorrhage, hypothermia and hypoglycaemia, iatrogenic prematurity, foetal compromise in labour, need for induction of labour, and cesarean delivery.[4]

The two phenotypes of IUGR (early and late) are distinct by the moment of onset, evolution, Doppler parameters modifications, and postnatal outcome.[5] The best cut-off between the two IUGR forms is 32 weeks in terms of perinatal outcome. With limited nutritional reserve, the foetus redistributes blood flow to sustain function and to help in the development of vital organs called the brain-sparing effect.

Campbell and Thoms introduced the idea of symmetric versus asymmetric growth.[6] symmetrically small foetuses were thought to have some sort of early global insult (e.g., aneuploidy, viral infection, foetal alcohol syndrome). Asymmetrically, small foetuses were thought to be more likely small secondary to an imposed restriction in nutrient and gas exchange.

Effective screening for intrauterine growth restriction requires accurate dating and includes a review of the mother's menstrual history, relevant assisted reproductive technology information, and either a first trimester or early second trimester dating ultrasound. Symphysis-fundal height determination is of limited value in routine obstetrical care, but is the only physical examination screening test.

Evaluation of causative factors for intrinsic disorders leading to growth restriction includes a foetal karyotype, maternal serology for infections and an environmental exposure history. Determining whether intrauterine growth restriction is symmetric or asymmetric is of less clinical importance than careful re-evaluation of foetal anatomy and uterine and umbilical artery Doppler studies.

An ultrasound examination for estimated foetal weight and amniotic fluid volume should be considered after 26 weeks if the symphysis-fundal height measurement in centimetres deviates by 3 or more from the gestational age in weeks or there is a plateau in symphysis-fundal height. In cases in which the foetus measures <10th percentile.

By estimated foetal weight or abdominal circumference measurement, the underlying cause of intrauterine growth restriction may be established by an enhanced ultrasound examination to include a detailed review of foetal anatomy, placental morphology, and Doppler studies of the uterine and umbilical arteries. Umbilical artery Doppler should be performed in all foetuses with an estimated foetal weight or an abdominal circumference <10th percentile.[7] When intrauterine growth restriction is diagnosed, surveillance should be initiated like serial ultrasound estimation of foetal weight along with umbilical artery, middle cerebral artery, umbilical vein, and ductus venosus Doppler studies.

MATERIALS AND METHODS

The purpose of our study was to evaluate the usefulness of pulsatility index of the UA and MCA as well as ratio of MCA PI to UA PI in the diagnosis of IUGR foetuses. Thus, this study was conducted with the aim to evaluate the use of Doppler ultrasound in management of IUGR pregnancy as a predictor of adverse perinatal outcome.

This was a prospective study in the department of obstetrics and gynaecology in a medical college over a period of 2 years. This study included 100 cases with singleton pregnancies of gestational age between 30 to 40 weeks with clinically suspected IUGR and were followed periodically with colour Doppler examination. Pregnancy with congenital malformations and multiple gestations were excluded from the study.

Detailed history including personal history, present and past medical and surgical history, past and present obstetric history noted. Also details of present pregnancy were noted including any risk factors for IUGR like anaemia, failure to gain weight, hypertension, bleeding during pregnancy or infections during pregnancy. All the patients were followed by serial Doppler assessment after clinical suspicion of IUGR. Followup Doppler studies were performed if clinically indicated to determine a favourable or a worsening trend in Doppler indices. However, only the results of the first Doppler ultrasound were used for analysis of prenatal outcome. Doppler assessment that is Umbilical Artery (UA) pulsatility index, Middle Cerebral artery (MCA) pulsatility index, MCA/UA Pulsatility Index ratio (Cerebroplacental ratio) was done by experts. The UA Pulsatility index ratios were considered abnormal if the value was above the 95th percentile of previously published values for gestational age. The MCA pulsatility index was considered abnormal if the value was below the 5th percentile of previously published values for gestational age.[8] The MCA/UA PI ratio (Cerebroplacental ratio) is usually constant during the last 10 weeks of gestation. It is possible to use a single cut-off value after 30th week because cerebral-umbilical Doppler ratio does not vary significantly between 30th and 40th weeks as reported.

Arbeille et al[9] found the cerebroplacental ratio constant during the pregnancy and suggested 1 as the cut-off value; all values below 1 were considered abnormal. Gramellini et al [10] also used a single cut-off value of 1.08.

Therefore, in our study a single cut-off value (1.08) was used, above which velocimetry was considered normal and below which it was considered abnormal.

The sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were determined for all Doppler measurements. Doppler US results were analysed for prediction of perinatal outcome for emergency CS for foetal distress, birth weight, Apgar score, need for NICU admission, perinatal death.

Pregnancy was considered to have "adverse outcome" when any of these complications were present, perinatal death, emergency CS for foetal distress, 5 minute Apgar score of less than 7, admission to NICU for complications of low birth weight. Pregnancy outcome was considered to be uneventful or favourable when the above complications were absent. Mode of delivery was decided according to the condition of the foetus and neonatal condition at birth was assessed by neonatologist and need for NICU admission was decided. These neonates were followed for their outcome for 1 month post-delivery.

RESULTS AND DISCUSSION

Maternal causes of IUGR account for most uteroplacental insufficiency. Pregnancy-induced hypertension is the most

common cause as it leads to failure of trophoblastic invasion by maternal spiral arterioles by 20 to 22 weeks of gestation causing luminal narrowing and medial degeneration, leading to diminished blood flow to the developing infant and causing restricted growth.[11] Infectious causes mainly "TORCH" group of infections cause foetal growth delay in about 10 percent of all cases of IUGR. Maternal prepregnancy weight and weight gain during pregnancy are considered strong indicators of birth weight.[12] Maternal weight gain of less than 10 kg by 40 weeks of gestation is clearly a risk factor for IUGR.[13]

Maternal Risk Factors	Number	Percentage
PIH	48	48%
Anaemia and malnutrition	20	20%
Placenta praevia	2	2%
Cardiac diseases	1	1%
Idiopathic	29	29%

Table 1. Aetiology/risk factors for IUGR

In our study, PIH was associated with majority of cases (48%) followed by malnutrition and anaemia (20%).

Adverse Outcomes	No. of cases
Intrauterine deaths	4
Emergency CS	40
Low Apgar score	18
Admission to NICU	25

Table 2. Adverse Pregnancy Outcome

Among live births with adverse outcomes, 15 had more than one adverse outcome.

Spectral Characteristics	No. of Cases	IUD	Mortality
Reversed EDF	3	3	100%
Absent EDF	3	1	33%

Table 3. Perinatal Outcome and Absent vs. reversed EDF in Umbilical Artery

Out of 4 IUDs, 3 cases had reversal of diastolic flow and 1 had absent diastolic flow. In all cases with reversal of diastolic flow, IUD of the foetus occurred within one week and was due to late followup with ultrasound reports.

Out of 3 patients who had absent EDF, 1 had IUD and rest of 2 patients required caesarean section, NICU admission for low Apgar and low birth weight.

The absent or reversed end-diastolic flows are strongly associated with an abnormal course of pregnancy and a higher incidence of perinatal complications, when compared to foetuses with IUGR characterised by the presence of end-diastolic flow.[14] The prevalence of perinatal death in foetuses with absent or reversed end diastolic flow velocity is reported to be over 40%. Yoon et al demonstrated in their study that AEDF is a strong and independent predictor of adverse perinatal outcome.[15]

Doppler Indices	TP	TN	FP	FN	Sensitivity	Specificity	Diagnostic Accuracy
UA PI	44	44	8	4	91%	84.6%	88%
MCA PI	42	24	28	6	87.5%	46%	66%
MCA PI/ UAPI RATIO	46	44	8	2	95.6%	84.6%	90%

Table 4. Performance Characteristics of Doppler Indices

Cerebroplacental ratio (MCA/UA PI Ratio) was most sensitive (Sensitivity 95.6%). It was more sensitive than either UA PI (Sensitivity 91%) or MCA PI (Sensitivity 87.5%) alone in predicting any adverse outcome. Cerebroplacental ratio and UA PI were equally specific (Specificity=84.6%) and MCA PI had comparably low specificity (Specificity=46%).

Arbeille et al described the cerebroplacental ratio for correlation of placental resistance and cerebral adaptation. This is constant during pregnancy especially after 30 weeks and suggested 1 as the cut-off value; all values less than 1 is considered abnormal.[16] This ratio is shown to have higher sensitivity (100%) in predicting adverse perinatal outcome and foetal hypoxia when compared to pulsatility index of MCA or umbilical artery alone (50%) according to study by T. Ozcan et al.[17] This correlates with our study results.

Shahina et al[18] concluded that the CPR ratio is a better predictor of SGA foetuses and adverse perinatal outcome than the MCA PI or the UA PI used alone; the UA PI can be used to identify IUGR per se, and the MCA PI alone is not a reliable indicator for predicting foetal distress. Jurisic et al[19] concluded that the reliability of CPR ratio in the estimation of foetal condition in preeclamptic patients is high. Very low CPR ratio values in patients with preeclampsia indicate that in these foetuses, foetal acidosis and foetal distress may be expected. Thus, low CPR reflects redistribution of cardiac output to the cerebral circulation and has been shown to improve accuracy in predicting adverse outcome compared with MCA or UA Doppler alone.

In our study, 68% patients with abnormal Doppler findings were delivered by caesarean section whereas only 18% of patients with normal Doppler findings required caesarean section for various indications. This is because of compromised status of IUGR foetuses with abnormal Doppler flows require immediate delivery. These results were comparable to study of Lakhakar et al which showed 62% caesarean rate in patients with abnormal Doppler studies.[20]

CONCLUSION

IUGR diagnosis and management still remains a challenge for obstetricians. Doppler ultrasound is a valuable modality for the evaluation of patients with clinically suspected intrauterine growth restriction.

Doppler evaluation of umbilical and middle cerebral arteries has an important role in the early diagnosis of clinically suspected growth retardation.

Abnormal cerebroplacental ratio <1 in particular, is a strong predictor of adverse perinatal outcome in IUGR. Absent and reversed diastolic flow in umbilical artery in IUGR is an ominous finding associated with increased risk of mortality.

Foetal Doppler study plays an important role in the management of IUGR pregnancies by early detection of compromised foetuses and timing delivery.

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